# Harmonic Solutions

Variable Frequency Drives

Allen-Bradley





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# Harmonics – A Pressing Subject

Harmonics refer to deviations from the desired model sinusoidal AC line voltage and the current waveforms. These deviations, or harmonic distortions, historically were low in magnitude. However, more recently, there has been a considerable increase attributed to the use of power electronics, non-linear commercial and industrial loads, and Variable Frequency Drives (VFDs). These deviations can influence the optimal performance of your connected devices.

## Potentially Negative Effects

The potential negative impacts of harmonic distortions on electrical systems include, but are not limited to:

- Component overheating
- Increase in supply transformer heat levels
- Random breaker tripping
- Shortened motor life
- Decreased device productivity
- Increased losses and reduced power factor can lead to increased energy cost

## Solutions Simplified Through Innovation

In order to reduce distortions and prevent system failures, facility engineers must mitigate harmonic distortions at their source.

Fortunately, reduction of harmonic distortions to acceptable levels is clear-cut.

- International Electrical and Electronics Engineers (IEEE) guidelines are often used to determine the acceptable level of harmonics in various systems
- Software tools are available that are used to predict the level of harmonic activity and evaluate mitigation solutions

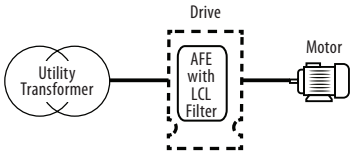
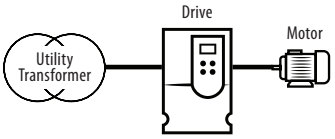
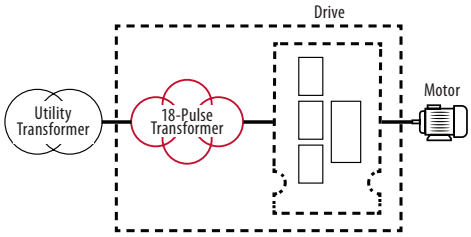
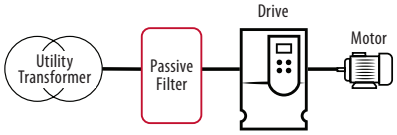
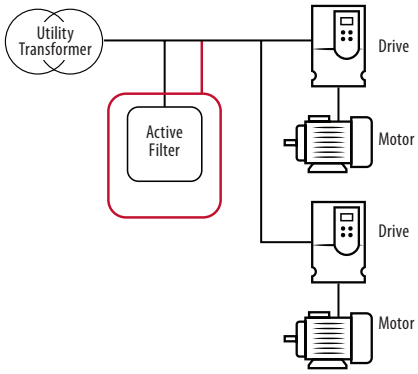
# Rockwell Automation Has Solutions

Avert potential system malfunctions by applying the proper technology and solutions to minimize and limit the effects of harmonic distortion on your devices. Rockwell Automation has developed a wide array of methods to reduce harmonics caused by non-linear loads. Several solutions are available that can be applied to meet your harmonic requirements, facility limitations, and budget needs. Allen-Bradley® PowerFlex® Drives enabled with low harmonic solutions such as active front end technology, 18-pulse arrangements, and active and passive harmonic filters have proven effective and can be configured to meet IEEE 519 standards.

| Harmonic Mitigation Solutions Checklist | PowerFlex 755T with Active Front End | 6 Pulse AC Drive with a DC Link Choke | 18 Pulse Converter with Auto Transformer | Passive Filter and 6 Pulse AC Drives | Active Power Filter |
|---|---|---|---|---|---|
| **Typical Current Harmonic Distortion (ITHD)** | 3 - 5% | 30 - 45% | 4.5 - 6% | 5 - 8% | 3 - 5% |
| **Meets IEEE 519** | Yes | No | Yes | Marginal | Yes |
| **Efficiency** | 97% | 97% | 96.5% | 96.5% | 96% |
| **Overall Size (Relative to 6-Pulse Drive)** | 1.5 - 2.5 | 1.0 | 3.0 - 5.0 | 2.0 - 6.0 | 2.5 - 5.0 |
| **Cost Effective** | Lower cost for IEEE 519 compliance and common DC Bus systems | Lowest Cost without harmonic requirements | Average cost for IEEE 519 compliance | Lower cost for <125 Hp applications | Lower cost for multiple AC drives |
| **Effect of 1% Voltage Imbalance** | Minimal | Large | Moderate | Minimal | Minimal |
| **Potential Low DC Bus** | No | No | No | Yes | No |
| **Potential System Resonance** | No | No | No | Yes | No |
| **Typical Total Power Factor, no/full load** | 1.0 | 0.75 - 0.95 | 0.90 - 0.99 | 0.3 - 1.0 Leading | 0.90-0.98 |
| **Predictive Maintenance of Major Components** | Yes[1] | Yes[2] | Inverter Only[2] | Inverter Only[2] | Inverter Only[2] |
| **Sense High Line Side Harmonics (Alarm)** | Yes | No | No | No | No |
| **Ease of Maintenance** | Yes | Yes | Inverter Only[3] | Inverter Only[3] | Inverter Only[3] |

1: PowerFlex 755T incorporate real-time predictive maintenance analytics on core components including fans, IGBTs, and capacitors based on actual use of the product
2: PowerFlex 753 and PowerFlex 755 6-pulse and DC input drives include timer-based predictive maintenance and may be included in low harmonic system
3: System including PowerFlex 753 and 755 6-pulse and DC input drives have easy to access replacement parts in inverters

## Harmonic Mitigation Techniques

| | | | |
|---|---|---|---|
| A | **PowerFlex 755T Drive with Active Front End** |  | This solution actively tracks and regulates input current to maintain sine wave current draw. This technique generates minimal voltage distortion allowing the input power converter to meet IEEE 519 at the input terminals of the drive. This method is cost effective on single drive applications typically greater than 50 horsepower, or on large common bus systems with many drives. Selecting a regenerative active front end drive allows for additional benefits for applications that traditionally require dynamic brake resistors. |
| B | **6 Pulse AC Drive with a DC Link Choke** |  | The DC Link choke helps provide a significant reduction in harmonics produced by the drive compared to a 6-pulse drive without a DC link choke. |
| C | **18 Pulse Converter with Auto Transformer** |  | An IEEE 519 compliant solution which includes standard magnetics in the form of an 18-pulse transformer. A traditional approach to achieve low harmonic solution. |
| D | **Passive Filter and 6 Pulse AC Drives** |  | This is a cost-effective solution at 125 horsepower and below. While greatly reducing harmonics compared to 6-pulse solutions, it may not be IEEE 519 compliant. It may cause a power system resonance condition in some installations. |
| E | **Active Power Filter** |  | External solution that actively monitors harmonic distortion levels and injects cancellation harmonic currents onto the line in order to meet IEEE 519 at the input of the active filter connection. Cost-effective solution on large systems with multiple AC drives on an single power distribution system. |

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